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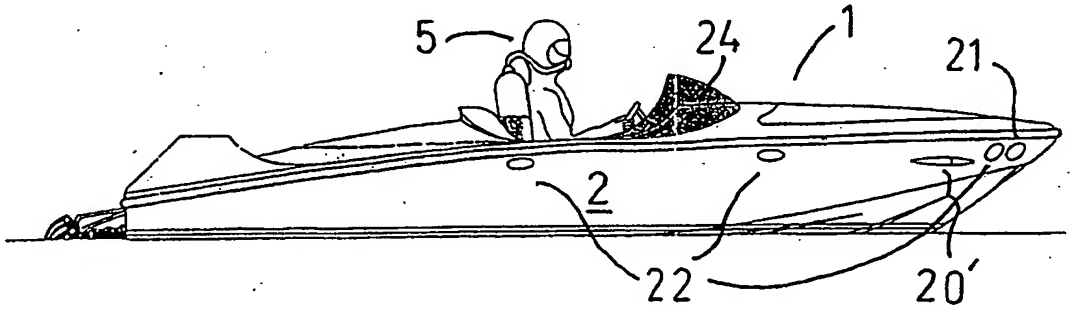

(57) Abstract

This invention provides a submersible boat (1) that is adapted for planing when driven at speed on the surface, and which has a non-enclosed cockpit. The boat has a hull (2) form which below its flotation line has a shallow V-form adapted for planing, and above its flotation line has a form providing an open cockpit having seating for at least one person (5) wearing underwater breathing apparatus. At least one system is provided for control of the boat when on the surface and when submerged, and at least one means is provided for propulsion of the boat on the surface and when submerged. Ballast tanks are provided to be filled with water to submerge the boat, and are provided with means to expel the water to enable the boat to surface. At least one means is provided for control of the boat in the vertical plane when submerged, for instance thrusters or hydroplanes.

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SUBMERSIBLE BOAT

This invention relates to a submersible boat. More specifically, this invention relates to a submersible boat which is capable of high speed on the surface, so as to allow planing.

Known submersible vessels have a wide variety of uses, both for scientific/technical purposes and for recreational use. Various types of manned vessels can be used either for work in shallow waters or for deeper exploration. In addition, submersibles provided with manipulation units are used for work associated with oil rigs, etc. Submersible vessels have also been used for tourist purposes, as in tropical waters. Such boats, however, have cabins which can be sealed against water pressure, thereby providing a "shirt sleeve" environment for crew and passengers.

WO 97/20732 describes a submersible boat that has positive buoyancy, with a sealable compartment for passengers, equipment or cargo, and with a vertical thrust system to provide depth control.

GB-A-801000 discloses a submersible boat intended for operation by a diver wearing a self-contained diving dress. It can be propelled by a motor, or even sailed or, because of its very low freeboard, it may even be propelled by paddling.

Semi-submersible vehicles have also been used for military purposes. For instance, the so-called chariots (human torpedoes) were employed during the Second World War for transporting explosive charges to be fixed to or left in the vicinity of moored vessels. These were, as their name suggests, basically an elaboration of torpedoes, and were driven by conventional torpedo-propulsion units, such as by compressed air.

The present invention, however, provides a boat which is capable of high surface speeds, and also of carrying one or more persons, already dressed in self-contained underwater breathing apparatus (Scuba equipment), sitting in an open cockpit, so that once the boat reaches the desired location, the surface propulsion system can be turned off and made watertight, and the boat can then be submerged for movement below the surface.

One embodiment of this invention provides a submersible boat adapted for planing when driven at speed on the surface, and having a non-enclosed cockpit, wherein such boat has a hull form which below its flotation line has a shallow V-form adapted for planing and above its flotation line has a form providing an open cockpit having seating for at least one person wearing underwater breathing apparatus, and at least one system for operation of the boat when on the surface and when submerged, means for propulsion of the boat on the surface and when submerged, ballast tanks operable to be filled with water to submerge the boat, and provided with means to expel the water to enable the boat to surface, and at least one means for control of the boat in the vertical plane when submerged.

The present invention will be described in more detail with reference to the accompanying Drawings, in which:

Fig 1 is a side elevation of a boat according to the invention above the waterline (flotation line);

Fig 2 is a view of the boat from above;

Fig 3 is a cut away view from above showing internal features;

Fig 4 is a section along the centre line of the boat;

Fig 5 is a view from the bows;

Fig 6 is a view from the stern; and

Fig 7 is a section along the lines X-X' of Fig 4.

Referring now to the Drawings, a boat [1] according to the illustrated embodiment of the invention has a hull [2] generally in the form of a fast-planing launch, having a transverse profile of shallow V-form, as will be seen more clearly from Figs 5 to 7.

The hull [2] is provided with an open cockpit [3] containing a pair of seats [4], each suitable for carrying a driver or passenger [5] wearing scuba equipment. Each seat can, if desired, have a gap at the back providing space for the air tank of the scuba equipment. For convenience and safety, each seat is provided with a steering wheel [6] and controls [7] for the propelling systems, etc are provided between the steering positions. If desired, however, there may be only one steering wheel.

In the embodiment shown, surface propulsion of the boat is provided by an air breathing motor [10] located in compartment [11] which is provided with a sealable air intake [12] and a sealable exhaust exit [13]. In a preferred embodiment, the air breathing motor is a diesel engine. Other forms of motor may be used, if desired, making use of an appropriate fuel, such as petrol or liquified petroleum gas. The air breathing motor is preferably used to drive a waterjet unit, which is steerable by a conventional steering train so as to provide vectored thrust. In addition, reverse thrust can be provided by an appropriate reversing bucket [15] operable to move into position over the outlet of the jet.

In the embodiment shown, propulsion when the boat is submerged is provided by a pair of reversible electric thrusters [16] driven by batteries [17]. Other types of thruster may be used, if desired.

When it is desired to submerge the boat, water can be admitted into the forward buoyancy/ballast tanks [18] and the aft buoyancy/ballast tanks [19]. Propulsion when submerged is provided by reversible electrically powered thrusters [16]. Control in the vertical plane is exercised in one embodiment by at least one thruster, that may, for instance, be swivelled in altitude or in azimuth for control. In another embodiment, control in the vertical plane is exercised through the hydroplanes [20, 20'] which can be operated together to direct the bows upwards or downwards, or in opposition in order to produce a degree of roll which will assist turning. When the boat is to surface, the water will be expelled from the forward and aft ballast tanks by compressed air stored in bottles [20]. Water can be cleared from the cockpit, etc by means of electric pumps (not shown), or by a pump of suitable capacity driven by the main motor [10]. If desired, conventional lights may be provided for surface navigation. For illumination when under water, forward-directed spot lamps [21] can be provided in the bows, and wider angled lights [22] can be provided both in the bows and on the beam of the boat. An anchor [23] which may optionally be remotely operated, can be provided in the bows. A pair of screens [24], or a single screen, provide some shelter from spray for the occupants of the boat when it is in motion on the surface, as well as underwater streamlining when the boat is in motion below the surface. Permanent buoyancy is provided by sealed spaces [25,25'] in the bows and stern.

The embodiment of the boat described herein is designed to carry two fully equipped Scuba divers at high speed of up to 35 knots on the surface of the water to their proposed diving site. The surface diesel propulsion unit [10] can then be switched off, all openings [12,13] sealed watertight, and the boat

flooded and submerged. Underwater propulsion is provided by the electric thrusters [16], capable of powering the boat at approximately 5 knots. The dive depth is only limited by the maximum depth that a free Scuba diver can dive.

The boat is conveniently built from fibre-reinforced plastic materials. As there is no pressure chamber for the crew, as on a conventional submarine, the structure is simple and lightweight. The embodiment shown is intended for use by just two divers, seated side by side, but other versions could, for example, seat up to 6 or more divers.

The boat is designed to be trailed and launched easily and therefore is constructed as light in weight as possible, as well as being well within the maximum width for towing. The embodiment described above has an overall length of 5.00m (16.4 ft), a waterline length of 4.20m (13.78 ft), a maximum beam of 2.00m (6.56 ft), and a surface draught of 0.30m (1.0 ft), and will have a displacement of approximately 1300 kg (2866 lb).

The hull form is unique in that it has a fully planing, shallow "V" form below the flotation line while above the flowing hull, the shape is desirably such as to minimise resistance when submerged.

Surface propulsion is provided by a diesel engine enclosed within a watertight casing. This unit drives a transom-mounted waterjet matched to the engine power. Steering is effected by vectoring thrust via a swivelling nozzle and a reversing bucket is also provided. The engine compartment [11] is sealed watertight by closing the intake [12] and exhaust exit [13]. A large capacity dive air compressor can be fitted to this engine, as well as a high capacity alternator for rapid battery charging, and a powerful ballast/bilge pump for use to evacuate the flooded boat when surfacing after a dive. The propulsion water jet can be disconnected via a clutch from the main engine. The air

intake and exhaust exit are located high on the craft, enabling the engine to run at full power immediately the craft surfaces in order to pump out ballast tanks and recharge batteries. Sufficient fuel can be carried for up to 6 hours at maximum speed.

Underwater propulsion is independently provided by two electrically powered thrusters, mounted high on the aft superstructure, clear of the bottom of the craft, rocks and the sea bed. As these units are electrically powered and widely spaced transversely, the thrust from each unit can be infinitely varied allowing the boat to be steered accurately at slow speed, using differential thrust on each unit. The direction of thrust can also be simply reversed allowing the boat to spin within its own length. Alternatively, vectoring thrusters can be used, or conventional rudders may be fitted to the boat. Batteries are carried, sufficient for approximately 2 hours continuous use underwater.

The diving mechanism is as built into a conventional submarine, whereby the fore and aft ballast tanks [18,19] are flooded until the boat sinks, to reach a neutral buoyancy which is adjusted to control the rate of descent. The ballast tanks are preferably so arranged to provide a slight bow-down trim upon diving to aid control.

To surface the boat, compressed air stored in standard dive bottles [20] is injected into the ballast tanks [18,19] to raise the boat. When the boat breaks surface, the main engine can be started to pump out the ballast tanks and dry out the boat. Also electric bilge/ballast pumps are provided.

During the dive, the ratio of ballast and air in the tanks can be finely adjusted to maintain the boat level, so as to compensate for any load carried or dive pressure differences.

The dive control system is simple. Two steering/control positions can, if desired, be provided for reasons of convenience and safety, operating on a linked dual control principle. Steering is via a conventional aircraft type wheel operating both the surface waterjet and the underwater thruster controls. Pushing the steering column forwards or backwards adjusts the means for controlling the underwater longitudinal attitude of the boat (e.g the thrusters or the front hydroplanes [20,20']), facilitating diving and surfacing of the neutrally buoyant craft. The thrusters or hydroplanes are so constructed as to produce roll in the craft as the boat is steered underwater, allowing the boat to roll into a turn thereby producing greater stability when turning at speed underwater.

In the embodiment described, the boat is fitted with two seats side by side. These seats can have a backrest designed to accommodate the conventional air bottle mounted on the diver's back, allowing the diver free escape from the boat if required. Quick release seat belts are also provided. In the illustrated embodiment, twin flow screens [24] are provided, one in front of each diver to reduce underwater resistance. A single screen protecting both divers can alternatively be used. Twin load carrying racks (not shown) are incorporated on the aft deck for carrying extra air bottles, or other equipment, or for stowing items recovered from the sea bed.

The boat can be ringed at gunwale level with observation lights, wide angle lights [22] on the beam side and spot lights [21] facing forwards. These can be varied in intensity to suit visibility conditions. Camera and special equipment brackets can be easily fitted. A protective cage can be fitted over the cockpit for use in hazardous areas, such as while shark watching.

Forward, a kedge type anchor [23] could be neatly stowed flush in the bow of the boat. This can be rapidly launched and retrieved under remote control

from the cockpit, the cable coiling on to an electrically powered reel. Alternatively, it could be separately operated by a diver.

The craft is also fitted with an emergency surface system, whereby all available air can be blown into the ballast tanks to ensure a rapid ascent. This feature could be remotely controlled from the surface should an unmanned submarine be lost.

The submersible boat according to the invention will have many uses. For instance, it can be used for recreational diving, such as around reefs, or for observation of whales. It can also be used for underwater filming, or for the routine checking and maintenance of underwater engineering installations. Because there is no need for the complexities resulting from the need to ensure that a closed cabin is leak-proof, many tasks presently undertaken using conventional submersibles may be undertaken at less expense than before.

CLAIMS

1. A submersible boat adapted for planing when driven at speed on the surface, and having a non-enclosed cockpit, wherein such boat has a hull form which below its flotation line has a shallow V-form adapted for planing and above its flotation line has a form providing an open cockpit having seating for at least one person wearing underwater breathing apparatus, and at least one system for control of the boat when on the surface and when submerged, means for propulsion of the boat on the surface and when submerged, ballast tanks operable to be filled with water to submerge the boat, and provided with means to expel the water to enable the boat to surface, and at least one means for control of the boat in the vertical plane when submerged.

2. A submersible boat as claimed in Claim 1 wherein the means for control of the boat in the vertical plane when submerged comprise at least one thruster.

3. A submersible boat as claimed in Claim 2 wherein the means for control of the boat in the vertical plane when submerged comprise at least one set of hydroplanes.

4. A submersible boat as claimed in any of Claims 1 to 3 wherein the means for surface propulsion comprise an air breathing motor in a sealable compartment.

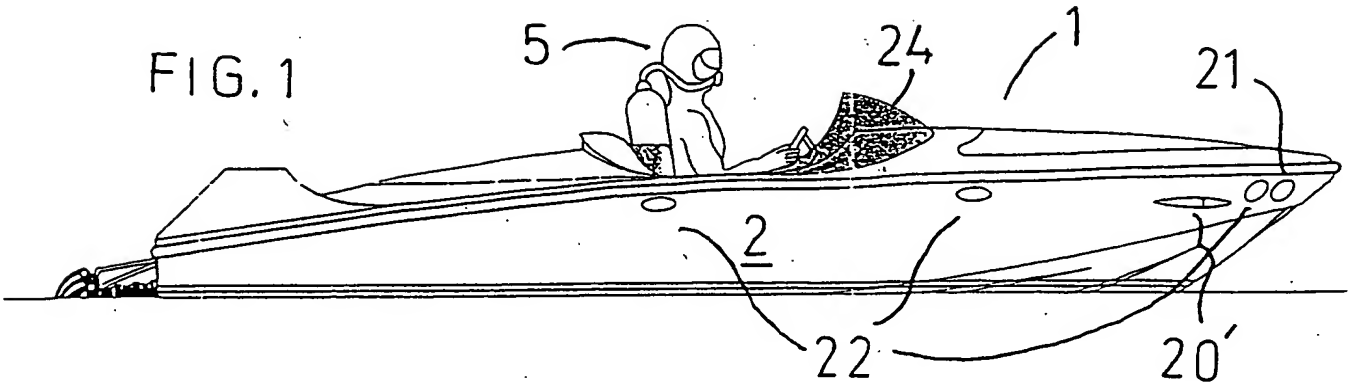
5. A submersible boat as claimed in Claim 4 wherein the motor drives a water jet unit.

6. A submersible boat as claimed in Claim 5 wherein the water jet unit is a steerable unit.

7. A submersible boat as claimed in any one of Claims 1 to 6 wherein the means for propulsion comprise at least one electrically powered thruster, and storage batteries for providing electric power to said thruster.

8. A submersible boat as claimed in Claim 7 wherein the thruster is a reversible thruster or vectoring thruster.

FIG. 1



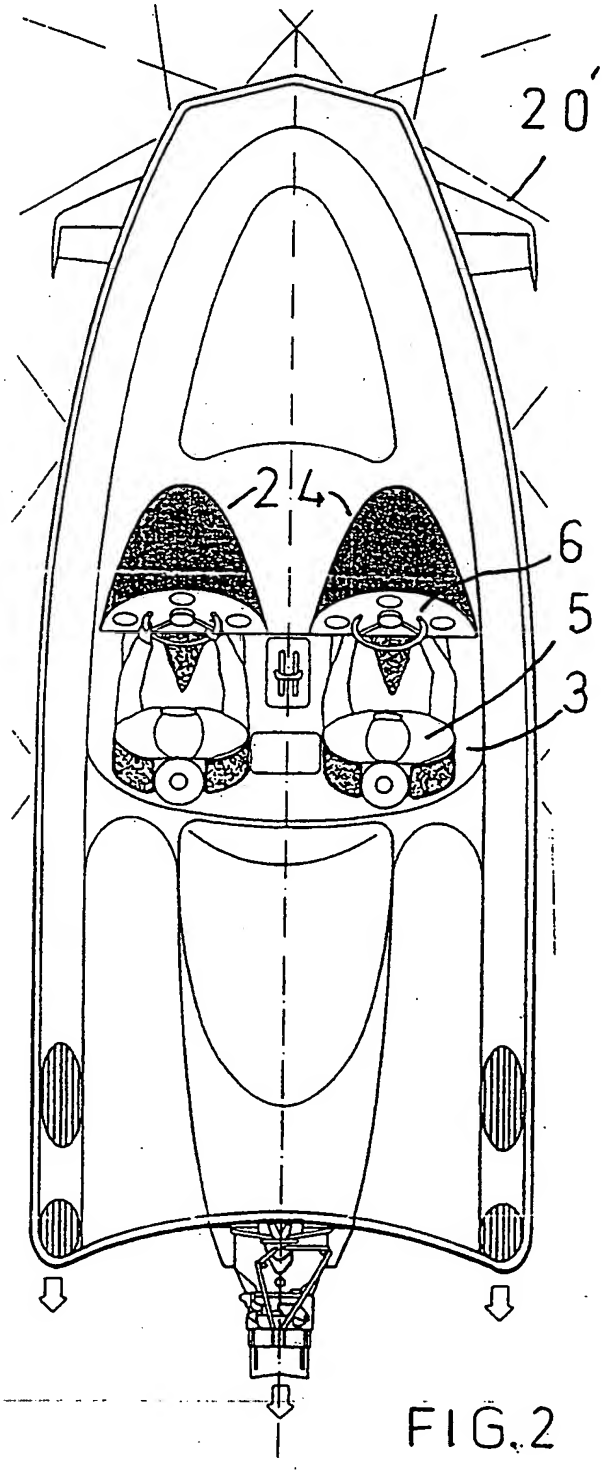


FIG. 2

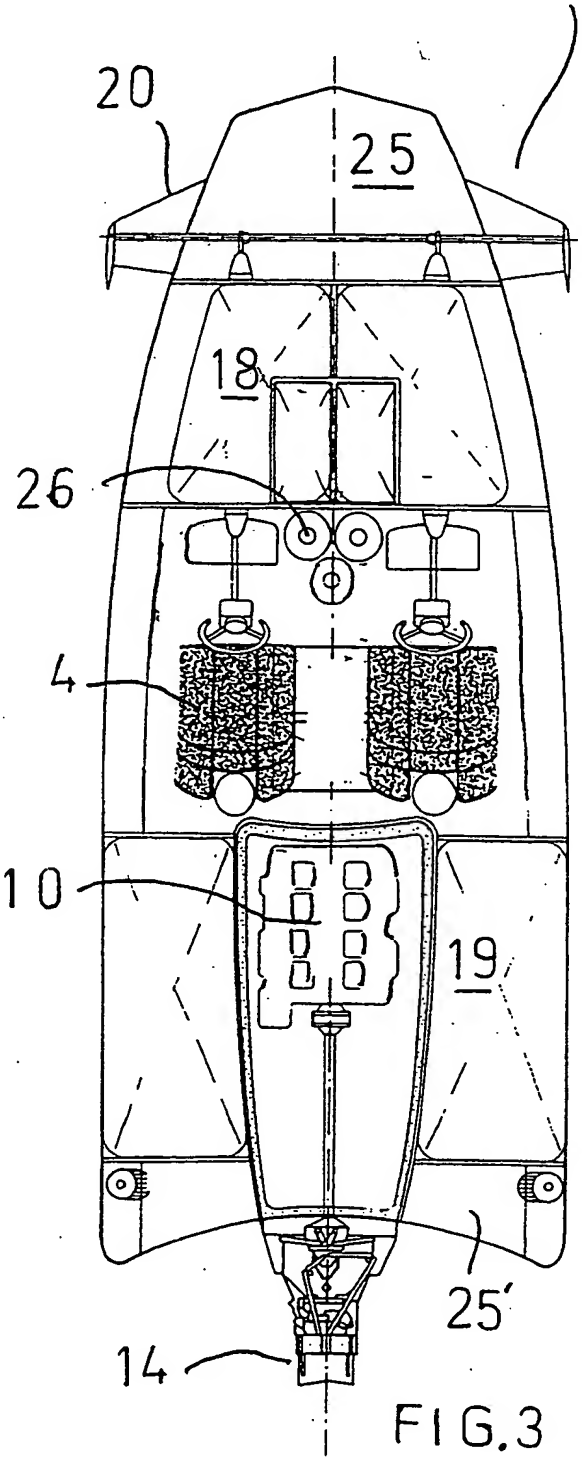


FIG. 3

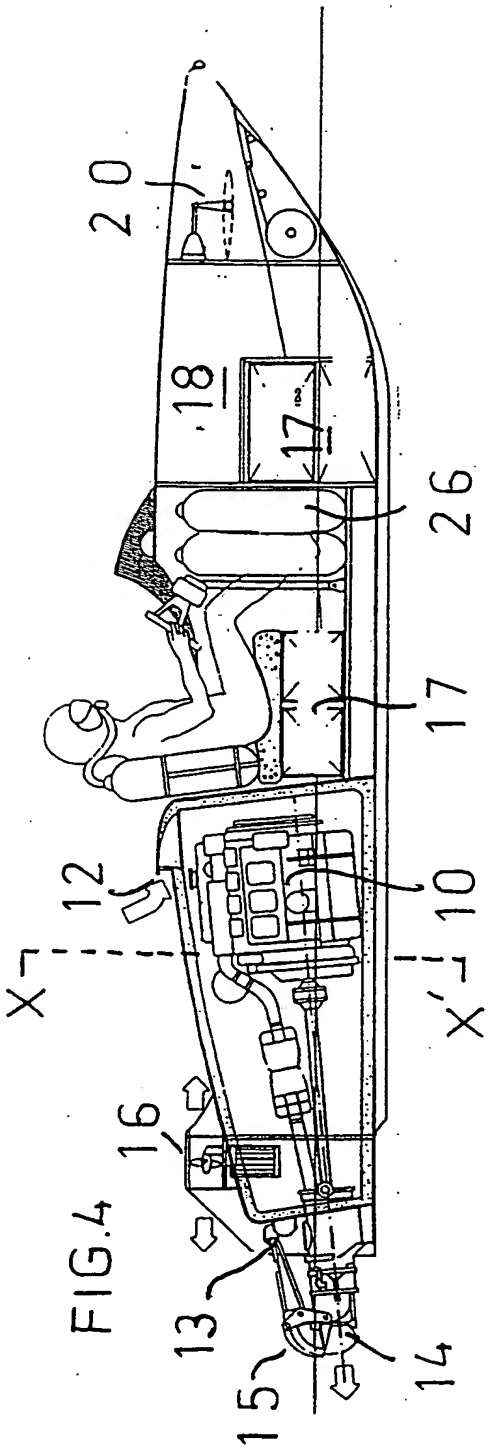


FIG.4

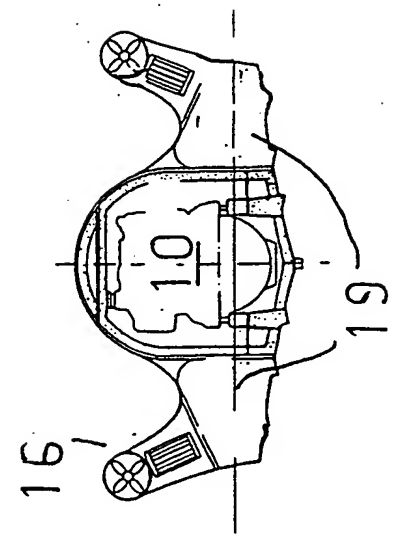


FIG.7

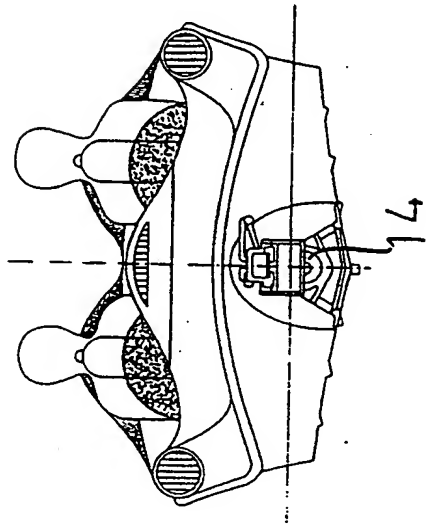


FIG.6

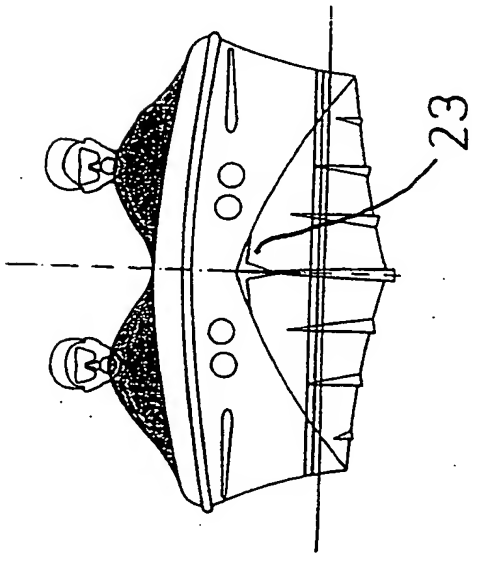


FIG.5